* NOTICES *

JPO and INPIT are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[0002]
[Field of the Invention]This invention relates to a microwave plasma processor and a method.
[0003]
[Description of the Prior Art]In recent years, in connection with the densification and high minuteness making of a semi conductor product, a plasma treatment apparatus may be used in the manufacturing process of a semi conductor product for processings, such as membrane formation, etching, and ashing. Since even the reduced pressure state of 0.1 thru/or about 10 mTorr is stabilized and plasma can be stood especially, the microwave plasma device made to generate high density plasma combining the magnetic field from microwave and a ring shape coil is proposed.
[0004]In a typical microwave plasma device, about 2.45-GHz microwave passes a waveguide, a transmission window, and a slot electrode in order, and is introduced in the processing chamber which the processed object has been arranged and was maintained under decompression environment, for example. On the other hand, reactant gas is also introduced into a processing chamber, and is plasma-ized by microwave, it becomes the strong radical and ion of activity, this reacts to a processed object, and etching etc. are performed.
[0005]Microwave has a dielectric (henceforth a "wavelength shortening member") which shortens the wavelength passed, before being introduced into a slot electrode. Thereby, since the wavelength of microwave becomes short, the interval of the slit formed in a slot electrode can be shortened. About the wavelength shortening member, it is indicated by JP,9-63793,A for which these people have already applied, for example.
[0006]Now, although a transmission window is formed with quartz, alumina, etc., it is heated with plasma heat, and is damaged, or it becomes vulnerable. A wavelength shortening member and a slot electrode are also expanded thermally with plasma heat. For example, although a slot electrode is formed by a copper plate etc., the optimal slit length changes with thermal expansion, the plasma density of the whole in a processing chamber falls, or plasma density concentrates selectively. If the whole plasma density falls, the processing speed of a semiconductor wafer will change. As a result, when plasma treatment is managed in time, even if it suspends processing in predetermined time (for example, 2 minutes), desired processing (etched depth and membrane formation thickness) may not be formed in the semiconductor wafer. If plasma density concentrates selectively, processing of a semiconductor

wafer will change selectively.
[0007]In order to solve this problem, JP,3-191073,A has proposed the microwave plasma processor which establishes the cooling method which uses cooling water and cools a transmission window, for example. It has proposed that above-mentioned JP,9-63793,A provides a cooling jacket in a wavelength shortening member and the covering member of a slot electrode (paragraph number).
[0008]Reference.
[0009]
[Problem(s) to be Solved by the Invention]However, in a plasma CVD device, as for the temperature of a processing chamber, since it will enter as an impurity into the film formed in a semiconductor wafer if moisture is liquefied or remains as misty state, raising as much as possible is preferred. However, the quality of plasma treatment will deteriorate only by establishing a cooling method simply like JP,3-191073,A. Thus, the evil of plasma heat was not able to be removed, maintaining the quality of a processed object conventionally.
[0010]It is necessary to control so that the temperature more than constant temperature is not applied about a member with weak tolerance over elevated temperatures, such as an O-ring which joins a processing chamber and a dielectric. As another technical problem, if it is not indicated and the construction material is not taken into consideration, heat conduction will become difficult to carry out what kind of construction material is used for a wavelength shortening member at JP,9-63793,A. therefore, temperature control -- butter fish -- ** -- the homogeneity of processing worsens.
[0011]Then, it sets it as the general purpose of this invention to provide the microwave plasma processor and method of operating within the new and useful decompression environment which solves such a technical problem.
[0012]
[Means for Solving the Problem]A microwave processor which is illustration 1 mode of this invention is provided with the following.
A wavelength shortening member which will shorten wavelength of the microwave concerned if microwave is introduced.
A slot electrode to which it shows said microwave which was connected to the wavelength shortening member concerned and passed said wavelength shortening member.
The 1st temperature controller that can control temperature of said wavelength shortening member and said slot electrode.
A processing chamber which can perform predetermined processing to said processed object under decompression environment if said microwave which could connect with a source of reactant gas and a vacuum pump which supply reactant gas, could store a processed object, and passed said slot electrode, and said reactant gas are supplied.
Said 1st temperature controller may control said slot electrode to temperature which controls that moisture adheres in said processing chamber. Said 1st temperature controller may control said temperature of said slot electrode at 70 ** **10 **. Said 1st temperature controller can control temperature of either one of said wavelength shortening member and said slot electrode, and can also control temperature of the other using one of the thermal conductivity concerned.
[0013]Said microwave plasma processor stores said wavelength shortening member, and have it further, and antenna member housing connected to said slot electrode said 1st temperature controller, By controlling temperature of said antenna member housing, temperature of said wavelength shortening

member and said slot electrode is controllable using thermal conductivity of said antenna member housing. Said microwave plasma processor has further a dielectric arranged between said slot electrode and said processing chamber, Said 1st temperature controller can control one temperature of said wavelength shortening member, said slot electrode, and said dielectric, and can also control temperature of said slot electrode using the one thermal conductivity concerned. Said microwave plasma device can have further the 3rd temperature controller that carries out temperature control of the circumference of the 2nd temperature controller controlled so that temperature of said processed object turns into predetermined treatment temperature, or said plasma device aforementioned dielectric.

[0014]A plasma processing method which is illustration 1 mode of this invention is provided with the following.

A process of storing a processed object to a processing chamber.

A process of controlling a pressure in said processing chamber.

A process of controlling temperature of a slot electrode.

A process of introducing reactant gas in said processing chamber, a process of supplying microwave to said slot electrode, and a process of processing said processed object with plasma by said microwave.

Said temperature control process may comprise a process of carrying out temperature control of the wavelength shortening member which can operate so that wavelength of microwave may be shortened, and a process of carrying out temperature control of said slot electrode only using heat conduction from said wavelength shortening member by which temperature control was carried out to said slot electrode.

[0015]A plasma processing method which is another illustration mode of this invention is provided with the following.

A process of storing a processed object to a processing chamber.

A process of controlling a pressure in said processing chamber.

A process of controlling temperature of a slot electrode.

A process of introducing reactant gas in said processing chamber, a process of supplying microwave to said slot electrode when said slot electrode becomes below prescribed temperature, and a process of processing said processed object with plasma by said microwave.

Said temperature control process may comprise a process of carrying out temperature control of the wavelength shortening member which can operate to below a predetermined temperature so that wavelength of microwave may be shortened, and a process of carrying out temperature control of said slot electrode only using heat conduction from said wavelength shortening member by which temperature control was carried out to said slot electrode.

[0016]Also in which an above-mentioned plasma processing method, said temperature control process, It may have further the process of comprising a process of carrying out temperature control of the dielectric connected to said slot electrode, and a process of carrying out temperature control of said slot electrode only using heat conduction from said dielectric by which temperature control was carried out to said slot electrode, and carrying out temperature control of said processed object.

[0017]

[Embodiment of the Invention]Hereafter, with reference to an accompanying drawing, the illustration microwave plasma device 100 of this invention used as a plasma CVD device is explained. In each figure, the same reference mark expresses the same member. Although the conventional microwave says the frequency of 1-100 GHz, the microwave of this invention says a thing (not only this but about 50 MHz - 100 GHz). Here, drawing 1 is a schematic block diagram of the microwave plasma device 100.

The microwave plasma device 100 of this example is provided with the following.
It is connected to the microwave source 10, the reactive gas supply nozzle 50, and the vacuum pump 60, and is the antenna member housing 20.
The 1st temperature controller 30.
Processing chamber 40.
The 2nd temperature controller 70.

[0018]The microwave source 10 consists of magnetrons and can usually generate 2.45-GHz microwave (for example, 5 kW), for example. Transmission forms are changed into TM, TE, or the TEM mode by the mode converter which does not illustrate microwave after that. In drawing 1, the isolator with which the generated microwave absorbs the reflected wave which returns to a magnetron, and EH tuner or the stub tuner for taking matching with a load side is omitted.
[0019]The wavelength shortening member 22 is stored by the antenna member housing 20, the wavelength shortening member 22 is contacted, and the slot electrode 24 is constituted as a bottom plate of the antenna member housing 20. It is in contact with the heat regulation board 32 so that material (for example, stainless steel) with high thermal conductivity may be used for the antenna member housing 20 and it may mention later. therefore, the temperature of the antenna member housing 20 -- the temperature of the heat regulation board 32 -- abbreviated -- it is set as the same temperature.
[0020]In order to shorten wavelength of microwave, it has a predetermined dielectric constant, and a predetermined material with high thermal conductivity is chosen as the wavelength shortening member 22. In order to make uniform plasma density introduced into the processing chamber 40, it is necessary to form many slits 25 in the slot electrode 24 mentioned later. The wavelength shortening member 22 has a function which makes it possible to form many slits 25 in the slot electrode 24. As the wavelength shortening member 22, alumina system ceramics and SiNAlN can be used, for example. For example, specific-inductive-capacity epsilont is about 9, and AlN is shortening-coefficient-of-wavelength n=1/(epsilont)1/2=0.33. The speed of the microwave which passed the wavelength shortening member 22 will be 0.33 time by this, and wavelength will also be 0.33 time, can shorten the interval of the slit 25 of the slot electrode 24 mentioned later, and makes it possible to form more slits 25.
[0021]The slot electrode 24 is screwed to the wavelength shortening member 22, for example, comprises 50 cm in diameter, and a cylindrical copper plate not more than thickness 1mm. As shown in drawing 2, it is started from the position which separated a few from the center about several centimeters outside, for example, and, as for the slot electrode 24, many slits 25 are spirally formed towards the edge part gradually. In drawing 2, the swirl of the slit 25 is carried out twice. In this example, the slit group is formed by arranging, as the slit pairs which make a group the slits 25A and 25B of the couple which made estrange slightly in the shape of an abbreviated T character, and has been arranged were mentioned above. The length L1 of each slits 25A and 25B is set up within the limits of the abbreviated 2.5 time of a free space wave length from abbreviated 1 / 2 of the guide wave length lambda of microwave, and width is set as about 1 mm, and the interval L2 of the outer ring of spiral wound gasket of a slit swirl and an inner ring is set as the guide wave length lambda and the length same in abbreviation, although there is slight adjustment. Namely, the length L1 of a slit is set up within limits shown by the following formula.
[0022]
[Equation 1]

$$\frac{\lambda_0}{2} \times \frac{1}{\sqrt{\varepsilon_t}} \leq L1 \leq \lambda_0 \times 2.5 \qquad \varepsilon_t: 比誘電率$$

Thus, it becomes possible by forming each slits 25A and 25B to form distribution of uniform microwave in the processing chamber 40. It is the outside of a spiral slit and the radiating element 26 for microwave power acid resisting about several millimeter wide is formed in the edge part of the disc-like slot electrode 24 along with this. This is raising the antenna efficiency of the slot electrode 24. The pattern of the slit of the slot electrode 24 of this example is mere illustration, and it cannot be overemphasized that the electrode which has arbitrary slit shape (the shape of for example, an L character, etc.) can be used as a slot electrode.

[0023]The 1st temperature controller 30 is connected to the antenna member housing 20. The 1st temperature controller 30 has a function controlled so that the temperature change of the component of the antenna member housing 20 by micro heat and this neighborhood becomes a predetermined range. As shown in drawing 3, the 1st temperature controller 30 has the heat regulation board 32, the sealing member 34, and the temperature sensor 36 and the heater device 38, and cooling water is supplied to it from the sources 39, such as a waterworks. As for the temperature of the cooling water supplied from the source 39 from the ease of control, it is preferred that it is constant temperature. The heat regulation board 32 has good thermal conductivity, such as stainless steel, for example, and the material into which it is easy to process the channel 33 is chosen. The channel 33 can be formed by penetrating the heat regulation board 32 of rectangular shape in all directions, and, for example, thrusting the sealing members 34, such as a screw thread, into a breakthrough. of course -- irrespective of drawing 3 -- the heat regulation board 32 and the channel 33 -- each can have arbitrary shape. Of course, the refrigerants (alcohol, Galden, chlorofluocarbon, etc.) of other kinds can be used instead of cooling water.

[0024]Well-known sensors, such as a PTC thermistor and an infrared sensor, can be used for the temperature sensor 36. Although a thermo couple can also be used temperature sensor 36, it is preferred to constitute so that it may not be influenced by microwave. It may connect with the channel 33 and the temperature sensor 36 does not need to be connected. Alternatively, the temperature sensor 36 may measure temperature of the antenna member housing 20, the wavelength shortening member 22, and/or the slot electrode 24.

[0025]The heater device 38 is constituted after considering it as heater wires etc. which were coiled around the surroundings of a water pipe connected to the channel 33 of the heat regulation board 32, for example. Water temperature which flows through the channel 33 of the heat regulation board 32 can be adjusted by controlling a size of current which flows into heater wires. water temperature of water in which the heat regulation board 32 flows through the channel 33 since thermal conductivity is high -- abbreviated -- it can be controlled by the same temperature.

[0026]The heat regulation board 32 touches the antenna member housing 20, and the antenna member housing 20 and the wavelength shortening member 22 have high thermal conductivity. As a result, temperature of the wavelength shortening member 22 and the slot electrode 24 is controllable by controlling temperature of the heat regulation board 32.

[0027]If there are not the wavelength shortening member 22 and the slot electrode 24 of 32 heat regulation board etc., temperature of the electrode itself will rise from power loss in the wavelength shortening member 22 and the slot electrode 24 by applying electric power (for example, 5 kW) of the

microwave source 10 for a long time. As a result, the wavelength shortening member 22 and the slot electrode 24 expand thermally and change.

[0028]For example, plasma density of the whole in the processing chamber 40 which optimal slit length changes with thermal expansion, and mentions later falls, or plasma density concentrates the slot electrode 24 selectively. If the whole plasma density falls, processing speed of semiconductor wafer W will change. As a result, when it sets up as processing was suspended and semiconductor wafer W was taken out from the processing chamber 40, when plasma treatment managed in time and carried out predetermined time (for example, 2 minutes) progress, If the whole plasma density falls, desired processing (etched depth and membrane formation thickness) may not be formed in semiconductor wafer W. If plasma density concentrates selectively, processing of semiconductor wafer W will change selectively. Thus, if the slot electrode 24 changes by a temperature change, quality of plasma treatment will deteriorate.

[0029]If there is no heat regulation board 32, since construction material of the slot electrode 24 differs from the wavelength shortening member 22 and both are screwed, the slot electrode 24 will curve. It will be understood that quality of plasma treatment deteriorates similarly also in this case.

[0030]On the other hand, if the slot electrode 24 has a constant temperature, even if it will be arranged under an elevated temperature, it does not produce modification. In a plasma CVD device, since it will be mixed as an impurity into a film of semiconductor wafer W if moisture is liquefied or exists with misty state, it is necessary to the processing chamber 40 to raise temperature as much as possible. Consideration of that members, such as O-ring 90 which seals between the dielectrics 28 later mentioned with the processing chamber 40, have the heat resistance of 80 thru/or about 100 ** will control the heat regulation board 32 (namely, slot electrode 24) to become about **5 ** on the basis of 70 **, for example. Preset temperature, such as 70 **, and allowable temperature ranges, such as **5 **, can be arbitrarily set up by the heat resistance and others of processing or members forming which are demanded.

[0031]In this case, the 1st temperature controller 30 acquires temperature information of the temperature sensor 36, and controls current supplied to the heater device 38 so that temperature of the heat regulation board 32 may be 70 ** **5 ** (using a variable resistor etc.). The slot electrode 24 is designed have the optimal slit length when placed under [on condition of being used at 70 **] 70 ** atmosphere. Alternatively, when the temperature sensor 36 is arranged at the heat regulation board 32, since it passes slot electrode 24 from the heat regulation board 32 or that heat spreads takes time to this reverse, tolerance level wider than using 70 ** **10 ** may be set up.

[0032]At first, since the 1st temperature controller 30 is lower than 70 **, temperature of the heat regulation board 32 placed under a room temperature may drive the heater device 38 first, may be about 70 ** in water temperature, and it may supply it to the heat regulation board 32. Alternatively, it is not necessary to pour water to the heat regulation board 32 until it becomes near 70 ** about a rise in heat by micro heat. Therefore, an illustration temperature control mechanism shown in drawing 3 may contain a massflow controller and an opening and closing valve which adjust amount of water from the source 39. When temperature of the heat regulation board 32 exceeds 75 **, for example, about 15 ** water is supplied from the source 39, and cooling of the heat regulation board 32 is started, and it controls so that the heater device 38 will be driven and temperature of the heat regulation board 32 will be 70 ** **5 **, when the temperature sensor 36 shows 65 ** after that. The 1st temperature controller 30 by using an above-mentioned massflow controller and an opening and closing valve, For example,

about 15 ** water is supplied from the source 39, cooling of the heat regulation board 32 is started, and when the temperature sensor 36 shows 70 ** after that, various control methods, such as suspending supply of water, can be adopted.
[0033]Thus, the 1st temperature controller 30 is different from a cooling method of JP,3-191073,A of only cooling without setting these up in that temperature control is carried out so that the wavelength shortening member 22 and the slot electrode 24 may become a predetermined allowable temperature range centering on predetermined preset temperature. Thereby, quality of processing in the processing chamber 40 is maintainable. For example, a meaningless thing will be understood only by cooling this at about 15 **, although optimal processing environment is acquired, when the slot electrode 24 is placed under 70 ** atmosphere and it is designed have the optimal slit length.
[0034]The 1st temperature controller 30 is controlling simultaneously temperature of the wavelength shortening member 22 and the slot electrode 24 by controlling temperature of water which flows through the heat regulation board 32. This depends the heat regulation board 32, the antenna member housing 20, and the wavelength shortening member 22 on having constituted from material with high thermal conductivity. By adopting this composition, since these three temperature control can be made to serve a double purpose with the device of 1, enlargement and a cost hike of the whole device can be prevented in that two or more devices are not required. The heat regulation board 32 is a mere example of a temperature control means, and it cannot be overemphasized that a cooling method of others, such as a cooling fan, is employable.
[0035]Next, the 3rd temperature controller 95 is explained with reference to drawing 4. Here, drawing 4 is a partial expanded sectional view for explaining the 3rd temperature controller 95. The 3rd temperature controller 95 carries out temperature control of the circumference of the dielectric 28 using cooling water, a refrigerant, etc. Like the 1st temperature controller, since it can constitute similarly using a temperature sensor and a heater device, the 3rd temperature controller 95 omits the detailed explanation.
[0036]Although the heat regulation board 32 and the antenna member housing 20 were separate members in this example, a function of the heat regulation board 32 may be given to the antenna member housing 20. For example, the antenna member housing 20 can be directly cooled by forming the channel 32 in the upper surface and/or the side of the antenna member housing 20. If the heat regulation board 98 which has the channel 99 similar to the channel 33 is formed in the side of the antenna member housing 20 as shown in drawing 5, it is also possible to cool simultaneously the wavelength shortening member 22 and the slot electrode 24. Here, drawing 5 is a partial expanded sectional view showing a modification of the heat regulation board 32 of the microwave plasma device 100 shown in drawing 1. A heat regulation board can be formed in the circumference of the slot electrode 24, or a channel can also be formed in slot electrode 24 the very thing so that arrangement of the slit 25 may not be barred.
[0037]The dielectric 28 is arranged between the slot electrode 24 and the processing chamber 40. For example, field junction of the slot electrode 24 and the dielectric 28 is firmly carried out by low at secrecy. The slot electrode 24 of copper foil may be formed so that pattern formation of the copper thin film may be carried out to shape of the slot electrode 24 which contains a slit by screen-stencil or other means and this may be alternatively printed on a rear face of the calcinated dielectric 28 made from ceramics. The dielectric 28 and the processing chamber 40 are joined by O-ring 90. When the circumference of the dielectric 28 is established in the 3rd temperature controller 95 that carries out temperature control to 80 ** thru/or 100 **, it is constituted as shown in drawing 4. The 3rd temperature

controller 95 has the channel 96 which encloses the dielectric 28 like the heat regulation board 32. Thus, since it is provided near O-ring 90, the 3rd temperature controller carries out temperature control of the dielectric 28 and the slot electrode 24, and it can also perform temperature control of O-ring 90 effectively. Consist of alumimium nitride (AlN) etc., a pressure of the processing chamber 40 in decompression or vacuum environment is impressed to the slot electrode 24, and the slot electrode 24 transforms the dielectric 28, or, The slot electrode 24 has prevented becoming unreserved in the processing chamber 40, and weld slag being carried out or generating copper contamination. The slot electrode 24 may be prevented from being influenced with temperature of the processing chamber 40 if necessary by constituting the dielectric 28 from construction material with low thermal conductivity.

[0038]Selectively, the dielectric 28 can be formed with construction material with high thermal conductivity (for example, AlN) like the wavelength shortening member 22. In this case, by controlling temperature of the dielectric 28, temperature control of the slot electrode 24 can be performed and temperature control of the wavelength shortening member 22 can be performed via the slot electrode 24. In this case, it is also possible to form a channel so that introduction to the processing chamber 40 of microwave may not be barred inside the dielectric 28. Temperature control mentioned above is also arbitrarily combinable.

[0039]In the processing chamber 40, a side attachment wall and a pars basilaris ossis occipitalis are constituted by conductors, such as aluminum, the whole is fabricated by tubed, and an inside can be maintained by the vacuum pump 60 mentioned later in predetermined decompression or vacuum seal space. In the processing chamber 40, semiconductor wafer W which is a processed object is stored at the hot platen 42 and an it top. In drawing 1, an electrostatic chuck, a clamping mechanism, etc. which fix semiconductor wafer W are omitted for convenience.

[0040]The hot platen 42 has the same composition as the heater device 38, and performs temperature control of semiconductor wafer W. For example, in plasma-CVD processing, the hot platen 42 heats semiconductor wafer W at about 450 ** in illustration. In plasma etching treatment, the hot platen 42 heats semiconductor wafer W at about 80 ** or less in illustration. Such cooking temperature by the hot platen 42 changes with processes. use any -- the hot platen 42 heats semiconductor wafer W so that moisture as an impurity adheres and may not mix at semiconductor wafer W. The 2nd temperature controller 70 can control a size of current for heating which flows into the hot platen 42 according to temperature which the temperature sensor 72 which measures temperature of the hot platen 42 measured.

[0041]The gas supply nozzle 50 made from a quartz pipe for introducing reactant gas into a side attachment wall of the processing chamber 40 is formed, and this nozzle 50 is connected to the source 58 of reactant gas by the gas supplying path 52 via the massflow controller 54 and the opening and closing valve 56. For example, when you are going to make it deposit a silicon nitride film, what mixed NH3, SiH4 gas, etc. can be chosen as predetermined mixed gas (namely, thing which added N2 and H2 to neon, a xenon, argon, helium, radon, or krypton) as reactant gas.

[0042]The vacuum pump 60 can carry out vacuum suction of the pressure of the processing chamber 40 to a predetermined pressure (for example, 0.1 thru/or several 10 mTorr(s)). A detailed structure of an exhaust system is also omitted in drawing 1.

[0043]Next, operation of the microwave plasma processor 100 of this example constituted as mentioned above is explained. First, semiconductor wafer W is stored to the processing chamber 40 by a transportation arm via a gate valve which is usually provided in a side attachment wall of the processing

chamber 40 and which is not illustrated. Then, semiconductor wafer W is arranged to a predetermined mounting surface by moving up and down lifter pins which are not illustrated.
[0044]Next, maintain inside of the processing chamber 40, predetermined process pressure, for example, 50mTorr, and from the nozzle 50. For example, it is introduced into the processing chamber 40, carrying out control of flow of NH3 to mixed gas of helium, nitrogen, and hydrogen via the massflow controller 54 and the opening and closing valve 56 from the one or more further mixed sources 58 of reactant gas.
[0045]Temperature of the processing chamber 40 is adjusted with the 2nd temperature controller 70 and hot platen 42 so that it may become about 70 **. The 1st temperature controller 30 controls the heater device 38 so that temperature of the heat regulation board 32 will be about 70 **. Thereby, temperature of the wavelength shortening member 22 and the slot electrode 24 is also maintained by about 70 ** via the heat regulation board 32. The slot electrode 24 is designed have the optimal slit length at 70 **. The slot electrode 24 assumes that it turns out beforehand that an about **5 ** temperature error is tolerance level. When plasma occurs, it may control to control heat at the time of plasma starting, as microwave is supplied when a slot also reaches below a predetermined temperature, since a slot electrode is heated with heat by plasma.
[0046]On the other hand, it introduces into the wavelength shortening member 22 in the antenna member housing 20 by the TEM mode etc. via rectangular waveguide, a coaxial waveguide, etc. which do not illustrate microwave from the microwave source 10, for example. The wavelength is shortened, and microwave which passed the wavelength shortening member 22 enters into the slot electrode 24, and is introduced into the processing chamber 40 via the dielectric 28 from the slit 25. Since temperature control of the wavelength shortening member 22 and the slot electrode 24 is carried out, there is no modification by thermal expansion etc. and the slot electrode 24 can maintain optimal slit length. Microwave can be introduced uniformly (namely, he has no partial concentration) into the processing chamber (namely, he has no fall of density) 40 by this by density of a request as a whole.
[0047]If temperature of the heat regulation board 32 rises rather than 75 **, the 1st temperature controller 30 will control this by continuous use to become less than 75 ** by introducing about 15 ** cooling water into the heat regulation board 32 from the source 39. Similarly, if temperature of the heat regulation board 32 will be 65 ** or less by the time of a processing start, or supercooling, the 1st temperature controller 30 can raise water temperature which controls the heater device 38 and is introduced into the heat regulation board 32 from the source 39, and can make temperature of the heat regulation board 32 not less than 65 **.
[0048]On the other hand, if the temperature sensor 72 detects that temperature of the processing chamber 40 turned into below prescribed temperature by supercooling by the heat regulation board 32, since moisture prevents adhering and mixing to the wafer W as an impurity, the 2nd temperature controller 70 can control the hot platen 42, and can control temperature of the processing chamber 40.
[0049]Then, microwave plasma-izes reactant gas and performs membrane formation processing. As for membrane formation processing, only predetermined time set up beforehand is performed, for example, and semiconductor wafer W is taken out from an above-mentioned gate valve which is not illustrated out of the processing chamber 40 after that. Since microwave of density of a request is uniformly supplied to the processing chamber 40, a film of desired thickness will be uniformly formed in the wafer W. Since temperature of the processing chamber 40 is maintained by temperature which moisture etc. do not mix in the wafer W, it can maintain desired membrane formation quality.
[0050]As mentioned above, although a desirable example of this invention was described, various

modification and change are possible for this invention within the limits of the gist. For example, since the microwave plasma processor 100 of this invention is not what bars use of a electron cyclotron resonance, it may have a coil etc. which generate a predetermined magnetic field. Although the microwave plasma processor 100 of this example is explained as a plasma CVD device, it cannot be overemphasized that it can be used also when the microwave plasma processor 100 etches semiconductor wafer W or it cleans. A processed object processed by this invention is not restricted to a semiconductor wafer, but contains LCD etc.

[0051]

[Effect of the Invention]According to the microwave plasma device of this invention, one or more temperature control can attain uniform processing.

[Translation done.]